# Pathological yawning as a presenting symptom of brainstem ischemia in two patients

Luigi Cattaneo, Laura Cucurachi, Elisabetta Chierici and Giovanni Pavesi
*Università degli Studi di Parma, Dipartimento di Neuroscienze, Sezione di Neurologia, Italy*
*luigi.cattaneo@nemo.unipr.it*
*J. Neurol. Neurosurg. Psychiatry published online 20 Sep 2005*

# Yawning : a behavior testifying arousal reinforcement during brainstem stroke

Electronic letters published: A response by
Olivier Walusinski
*MD, F.28160 Brou*
*walusinski@baillement.com*
*J. Neurol. Neurosurg. Psychiatry published online 29 Sep 2005*

---

The two case reports by Cataneo et al. have the great interest to complete the knowledge about yawning. Our purpose is to give another view of the meaning of excessive yawning observed during brainstem stroke.

Among mammals, there are three types of morphologically identical yawns occurring in three distinct situations: situations relative to circadian rest-activity rhythms, situations relative to feeding, situations relative to sexuality or social interactions (1).

Until now, no specific cerebral structure has been identified as a yawning centre. A good number of clinical and pharmacological arguments indicate that yawning involves the hypothalamus (particularly the paraventricular nucleus), the bulbus and pontic regions, with frontal region connections in primates and to the cervical medulla (2).

During the few hours of life of anencephalous babies, it has been noted that they yawn and stretch, a sign of the mammalian syndrome of awakening activity or « Rekel Syndrom » (3).

Patients afflicted with the locked-in syndrome, still yawn, despite being paralysed (4,5,6,7).

These show that yawning originates in the brain's archaic structures common to all vertebrates. The central nervous system is based on a common overall organisational plan and reveals, from the most ancient to the most recent vertebrates, a gradual increase in complexity corresponding to life levels that are increasingly independent and functionally developed.

Yawning helps understand the phylogenesis of the encephalon by inferring a functional organisational pattern of the nervous system similar to that advanced by Paul MacLean (8) with the superposition of: (a) an ancestral "reptilian" brain (brain stem and diencephalon), where yawning originates; (b) a "paleomammalian" brain (limbic system) common to all mammifers, functioning as a synaptic and humoral interface, in fact the seat of the monkeys' emotivity yawn; (c) a "neomammalian" brain characterised by human's cortical development, particularly the frontal lobes, seat of the "contagious" yawn.

The phylogenetic appearance of sleep proposes that the nocturnal rest of poikilotherms most probably becomes in mammals a form of the rapid eye movement sleep (REM sleep) or paradoxical sleep which is caracterized by peripheral muscular atonia originating in the dorsal part of the brainstem, rostral to the pons (9).

The ultrasound investigation specifies is ontogenesis precociousness between 12 and 15 weeks of gestation. Based on numerous studies of fetuses and infants in a variety of mammalian species, it is widely believed that the earliest form of sleep is properly characterized as active sleep, that is an immature form of REM sleep and preponderant at birth. Accordingly, it is thought that quiet sleep, an immature form of slow-wave sleep (SWS), emerges as REM sleep's predominance diminishes during ontogeny.

Behavioral pattern continuity from prenatal to postnatal life shows a strict parallelism between the ontogeny of REM sleep and yawning. Basically, REM sleep in the human declines from 50% of total sleep time (8 h) and a frequency of

30 to 50 yawns per day, in the fetus and newborn, to 15% of total sleep time (1 h) and less than 20 yawns per day, in the adult. This decrease takes place mainly between birth and the end of puberty. As a flip-flop switch, the reciprocal interactions between sleep and wake promoting brain regions allow the emergence of distinct states of arousal. By its ontogenical links with REM sleep, yawning appears as a behavior which procures an arousal reinforcement through the powerful stretch and the neuromuscular rewiring induced. The powerful muscular contraction caused by yawning releases arousal by activation of the reticular-formation (locus coeruleus) to which the cranial nerves send retro-projections. At becoming aware, the yawning and stretching reverse the muscular atonia which characterize REM-sleep (10).

Face-scratching, nose-face rubbing movements, yawning, sighs have been reported as automatisms before or after typical absence seizures or minimal epileptic seizures arising from sleep and they evoke temporal lobe seizures (11). These behaviors are also seen as a characteristic behavioral pattern of the arousal from sleep in healthy subjects. Velocity and repetition of the movements change in a different physiological (sleep arousal) or pathological (epileptic seizure, brainstem stroke) context. These behaviours can be related to the activation of brainstem and diencephalic circuitries, where the 'central pattern generators' of these behaviours are located, when cortex appears as deconnected by the epileptic discharge or stroke.

The networks controlling awaking must be tonically reinforced and yawning apparears as a behaviour testifying arousal reinforcement.

**Reference**

(1) Walusinski O, Deputte B. The phylogeny, ethology and nosology of yawning. *Rev. Neurol. (Paris)*. 2004 Nov;160(11):1011-21. Review. French.

(2) Baenninger R. On yawning and its functions. *Psychonomic Bul. Rev.* 1997;4(2):198-207.

(3) Gamper E. Bau und Leistungen eines menschlichen Mittelhirnwesens (Arhiencephalie mit Encephalocele). *Zeitschr. f. d. ges. Neurol. u. Psychiat.* 1926;104:49-120.

(4) Gschwend J. Yawning in a case with transsecting glioma of the pons *Fortschr. Neurol. Psychiat.* 1977;45:652-655.

(5) Bauer G, Gerstenbrand F, Hengl W. Involuntary motor phenomena in the locked-in syndrome. *J. Neurol.* 1980;223:191-198.

(6) Ghika J, Vingerhoets F, Bogousslavsky J. Dissociated preservation of automatic-voluntary jaw movements in a patient with biopercular and unilateral pontine infarcts. *Eur. Neurol.* 2003;50(3):185-188.

(7) Krasnianski M, Gaul C, Neudecker S, Behrmann C, Schluter A, Winterholler M. Yawning despite trismus in a patient with locked-in syndrome caused by a thrombosed megadolichobasilar artery. *Clin. Neurol. Neurosurg.* 2003 Dec;106(1):44-46.

(8) MacLean P. Evolutionary psychiatry and the triune brain. *Psychol. Med.* 1985;15:219-221.

(9) Nicolau MC, Akaarir M, Gamundi A, Gonzalez J, Rial RV. Why we sleep: the evolutionary pathway to the mammalian sleep. *Prog. Neurobiol.* 2000 Nov;62(4):379-406.

(10) Walusinski O, Kurjak A, Andonotopo W, Azumendi G. Fetal yawning assessed by 3D and 4D sonography. *The ultrasound Rev. Obst. Gynecol.* 2005;5(3):210-217.

(11) Meletti S, Cantalupo G, Stanzani-Maserati M, Rubboli G, Tassinari A. The expression of interictal, preictal, and postictal facial-wiping behavior in temporal lobe epilepsy: a neuro-ethological analysis and interpretation. *Epilepsy Behav.* 2003;4(6):635-643.